ESA-053-2 General Shale Roanoke Plant
PUBLIC REPORT

Introduction: Bob Scott performed a three day Energy Savings Assessment at the General Shale manufacturing facility outside Roanoke, VA starting April 25, 2007 and ending April 27, 2007. General Shale manufactures various high quality bricks at the Roanoke plant, which are used for residential and commercial construction. The facility currently operates three brick kilns. The heat from the kilns is used to dry the formed wet brick. All three kilns have recently been converted from 100% natural gas firing to coal as the primary heat source. Natural gas is still used in the kilns for preheating and flashing the brick. General Shale pioneered this method of utilizing coal firing in the brick production process, and the Roanoke plant was converted due to high natural gas prices in recent years.

Objective of ESA: The objective of the ESA was to assist the plant in obtaining a better understanding of energy savings opportunities in each process heat application, and to evaluate overall energy management practices.

Focus of Assessment: The focus of the assessment was to help the facility better understand overall energy usage in the manufacturing process and to provide an energy balance for utilization of natural gas, coal and electricity. The PHAST tool was introduced to the staff at the facility to obtain a process heat balance for the plant and to model each of the three brick kilns. The PHAST tool was then applied to identify and quantify opportunities for energy savings. Opportunities to better manage electricity within the current electric rate structure were also investigated.

Approach for ESA: The approach for the ESA was to hold a kick off meeting with the plant lead at the start of the ESA. Detailed discussions followed on the current operation and history of fuel utilization at the facility. In the morning and afternoon of the first day an extensive plant tour was conducted with the plant lead to obtain an overview of the process heat equipment and various manufacturing operations. The natural gas and electric bills were provided for the past 12 months. The second day was spent developing the PHAST energy balance and obtaining process measurements from the plant data collection systems to identify specific energy savings opportunities through modeling the process heat equipment. The Corporate Manager of Process Research arrived in the afternoon of the second day and provided needed inputs required for the PHAST model. On the third day, the Corporate Energy Manager arrived on site and energy procurement and utilization issues were discussed with the team. The plant lead and technical support personnel were then trained on PHAST and the program and data files were loaded on their computers. The preliminary findings for energy saving opportunities were reviewed with the team and a presentation followed with the Plant Manager in attendance. The recommendations were reviewed with the team, and a detailed discussion followed.

General Observations of Potential Opportunities:

- Total plant natural gas usage for base year, April 2006 to March 2007 was 124,682 MMBTU. In addition, coal usage of 3278 tons for the 4th quarter of 2006, which projects to 275,000 MMBTU/year, was obtained from the Corporate Energy Manager.

- Natural gas costs vary monthly, due to market conditions and corporate purchasing practices. Fuel usage was normalized for each kiln based on March 2007 production. The impact electric cost is $0.0535/kWh.

Several opportunities to save energy used for process heat and plant utilities were identified during the ESA and the follow-up evaluation. A brief summary of each recommendation is described below:

Plant Electrical Savings

The plant electrical bill was evaluated during the baseline period. Appalachian Power, the electric utility, recently implemented a rate increase. The new electric rate has been provided to General Shale plant and corporate personnel. The billed electric demand at the facility has increased 462 kW for the period from January - March 2007 over the previous 9 months. Some of this increase is due to production increases, however it is estimated that the demand could be reduced 350 kW through a load management program. Electric interval data, showing electric usage in 30 minute periods, would need to be obtained from the electric utility to determine exactly when the peaks were occurring. Then a demand management and equipment scheduling program could be implemented. Potential savings of $51,600 are estimated based on a billed demand charge of $12.29/kW per month. This is considered a **Near Term** opportunity for energy savings.

In addition, the evaluation of the plant electric bill revealed that the plant was paying a power factor penalty averaging $1108 per month over the past 5 months. The power factor penalty is based on the highest peak period kVAR reading being greater than 50% of the peak kW. This has occurred for each of the past six months evaluated under the new electric rate. The increase in kVAR is most likely related to the peak demand increase, or the possible failure of any existing capacitors. It is estimated that 685 kVAR of capacitance would need to be installed to eliminate the power factor penalty. At an estimated capital cost of $50/kVAR, this project would cost $34,200 and result in a payback of 2.57 years. This is considered a **Medium Term** opportunity for energy savings.

Plant Process Heat Savings

Kilns A and B in Plant 35 and the kiln in Plant 36 were modeled in PHAST to determine savings opportunities. Savings are based on 24.6% natural gas usage at Plant 35 (both kilns) and 35.67 % natural gas usage at Plant 36. Data from the March 2007 daily kiln burn reports for Plant 35 were used to produce the normalized annual data. Plant 36 natural gas usage was determined by the difference between the main utility natural gas meter and the sum of the two plant 35 meters. It is recommended that the gas readings for plant 36 should be taken from the billing quality natural gas turbine meter on the top of the kiln. The information from the data acquisition system on plant 36 that produces the daily burn report was difficult to understand and did not balance with the other natural gas meters. A natural gas cost $12.14 from March 2007 was used in the savings analysis.

The total fuel usage per pound of brick produced was calculated at 853 Btu for the two kilns at Plant 35 and 818 Btu/lb for Plant 36. All three kilns run on very high levels of excess air according to information provided by Roderick Schutt, Manager of Process Research. We attempted to obtain oxygen readings to confirm the excess air, but we could not find an access point that provided usable readings. The oxygen levels in the exhaust used in the PHAST model were 17% in the two kilns in Plant 35 and 15% for Plant 36. It is understood that brick kilns are designed for high levels of excess air to provide good mass transfer, heat distribution and complete combustion. In addition, reducing excess air could affect the heat transfer and product quality of the brick. However, reducing oxygen 1% in the exhaust would produce energy savings of $44,811 in Plant 35 and $35,972 in Plant 36. The reduction of excess air would be considered a **Medium Term** opportunity as the combustion air system and controls may require modifications to allow this measure to be implemented. In addition a test should be performed on one kiln or in the laboratory to predict any adverse affects on the brick quality from this energy savings measure.

An infrared temperature gun was used to measure the outside wall temperatures of all three kilns. The measurements showed that there are hot spots on the outside of both kilns on Plant 35 that result in an overall outside wall temperature that is approximately 50 degrees F hotter (200° vs. 150°) than the kiln in Plant 36. The PHAST model shows that a reduction in average outside wall temperatures of 30°F, which could be achieved by marking hot spots and increasing insulation, would result in annual savings of $28,600 for Plant 35. This is considered a **Medium Term** opportunity as the kiln must be at least partially shut down after the survey to make the changes.

The most significant process heat energy cost savings opportunity would result from reducing natural gas usage in Plant 36. The plant energy balance shows that Plant 36 uses 35.9% natural gas as discussed above. The calculations show that if natural gas is reduced to 30.9% of total fuel used in the kiln, annual savings of $97,814 are projected with current fuel costs. The plant has an ongoing effort to reduce natural gas usage at Plant 36. This may require increased limestone usage in the scrubber and more precise fuel measurement and burner control. This is considered a **Near Term** opportunity as the changes can be accomplished with improved operating practices and without modifications of existing equipment.

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The estimated reductions in natural gas usage are 8.26% from the **Near Term** opportunity and 3.65% from the two **Medium Term** opportunities identified.

Management Support and Comments:

DOE Contact at Plant/Company: The DOE plant contact for follow-up is Gary Jones, the Assistant Plant Manager.